3.7 Design of Bridge Superstructure

3.7.1 Loading Criteria

The following specifications are used to set up the loading conditions on the superstructures of proposed bridges.

- Peraturan Perencanaan Teknik Jembatan May 1992 BINA MARGA (BMS) (Bridge Design Code)
- Design Manual, December 1992 BINA MARGA

However, for requirements of design not covered by the above specifications, the AASHTO or Japanese Specification for Highway Bridges as well as Japanese Specification for Pedestrian Bridges will be applied.

According to the above specifications, the basic design standards are as follow :

(1) Traffic Load

(a) Intensity of "D" Lane Loading

The "D" lane loading consists of uniformly distributed load (UDL) combined with a knife edge load (KEL) as shown in Fig. 3.5 and Fig. 3.6.

UDL load intensity : q (kPa)

Where,

$L < 30$ m $q = 8.0$ (kPa)
$L \geq 30$ m $q = 8.0 (0.50 + 15/L)$ (kPa)
L : load length (m)

KEL load intensity : p (kN/m)
$p = 44$ (kN/m)

(b) Magnitude of "T" Truck Loading

The "T" truck loading is a single heavy vehicle with three axles as shown in Fig. 3.7. "D" loading is applied to design of bridges in this project except for small span bridges.

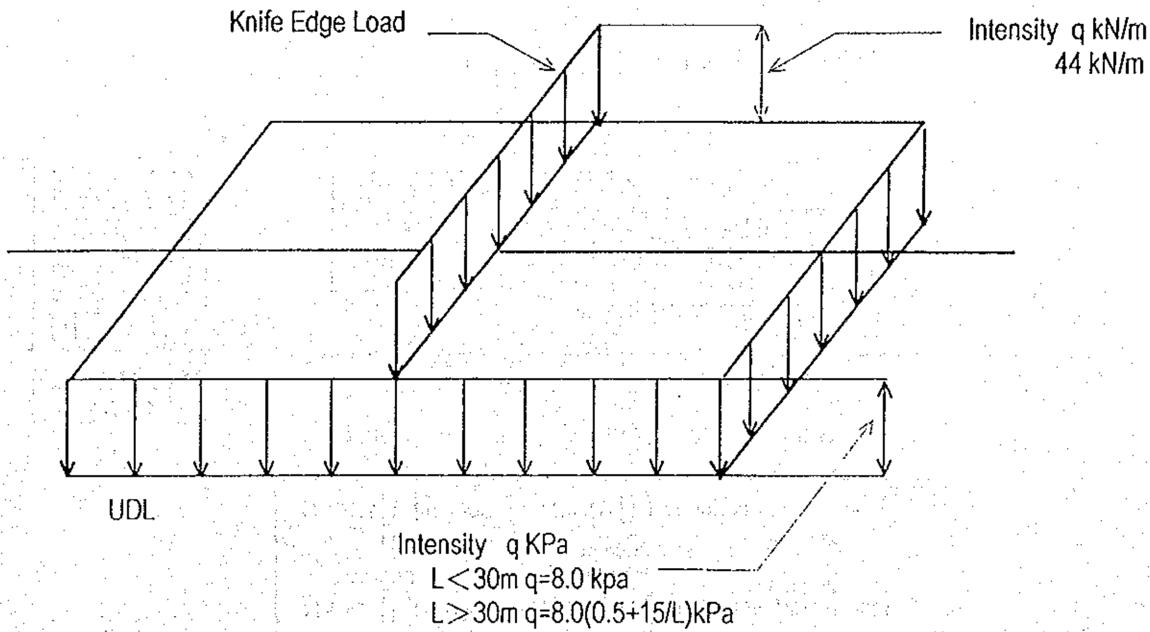


Fig. 3.5 "D" Lane Loading

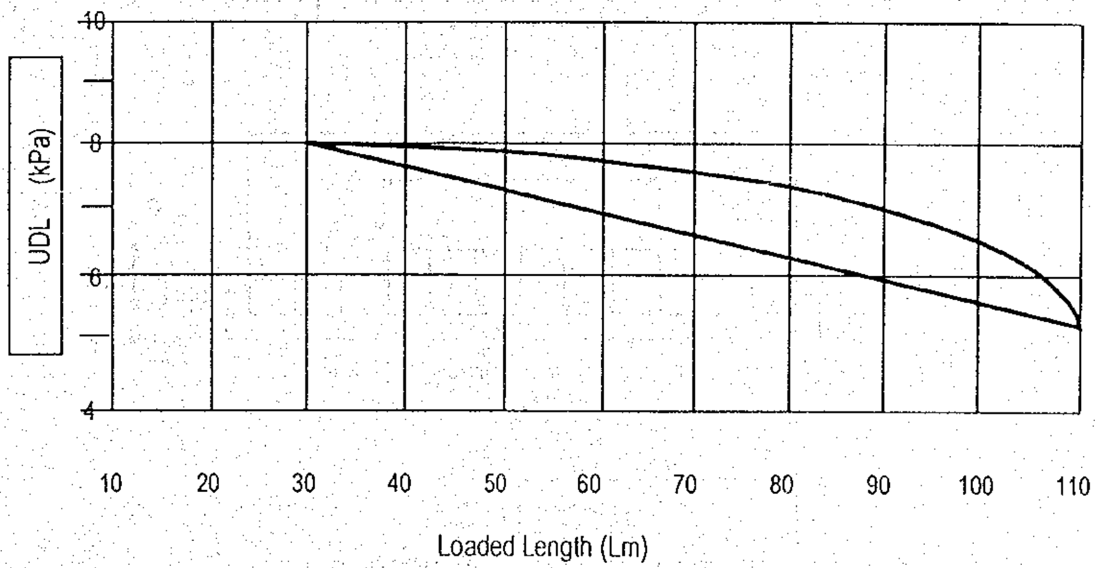


Fig. 3.6 " D" Loading : UDL vs Loaded Length

Wheel load (T) = 10 ton/wheel

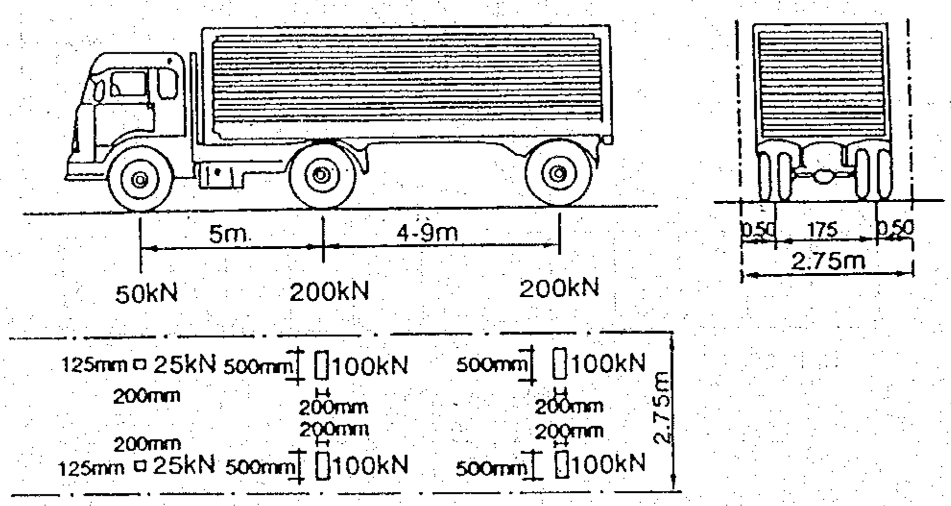


Fig. 3.7 "T" Truck Loading

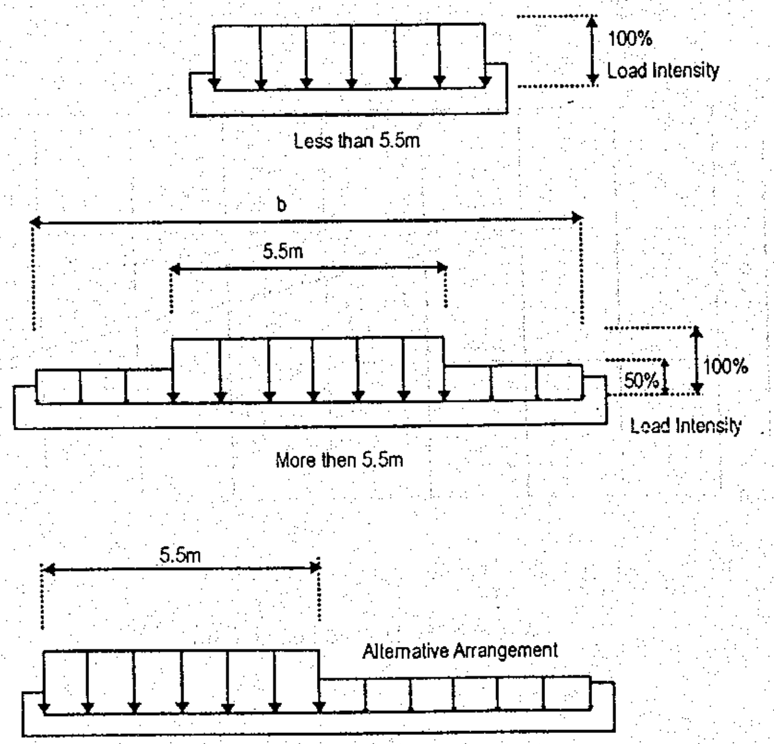
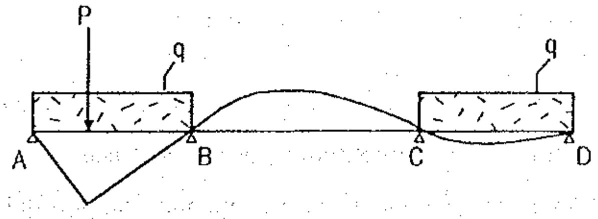
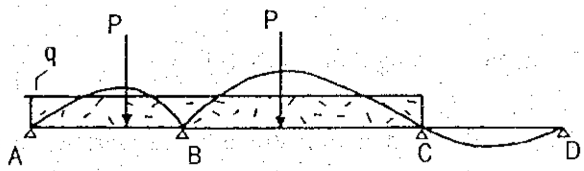


Fig. 3.8 Lateral Distribution of "D" Lane Loading

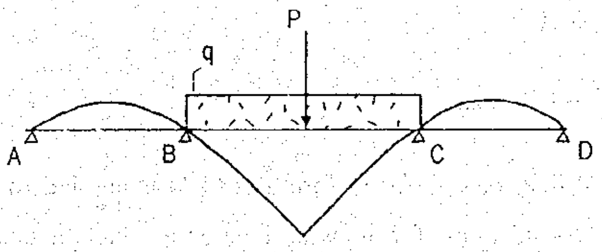
AT SIDE SPAN



AT SUPPORT B



AT CENTRE SPAN



Note : P Denotes line load, and q denotes uniform load.

Fig. 3.9 Maximum Positive and Negative Bending Moment

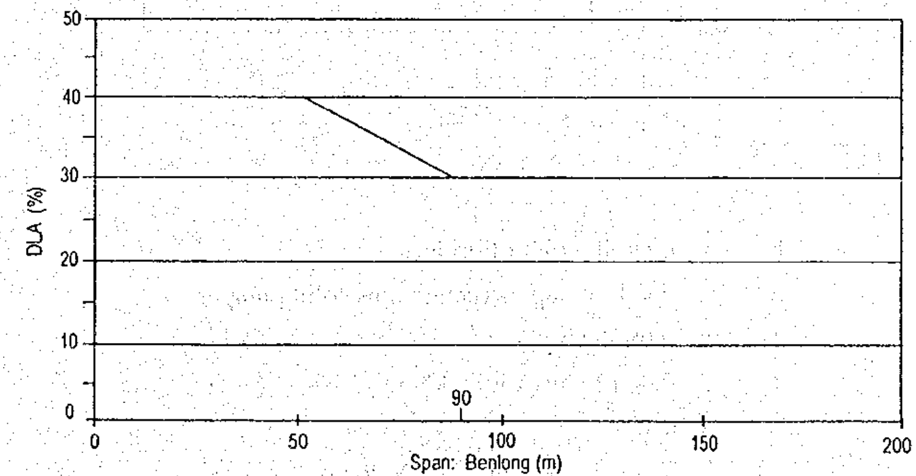


Fig. 3.10 Dynamic Load Allowance for KEL of "D" Lane Load

(c) Magnitude of "T" Truck Loading

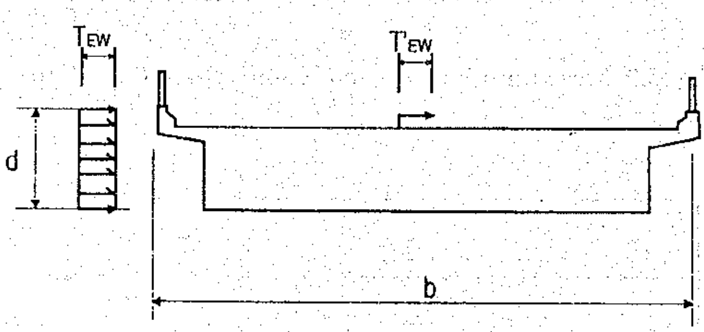
The reduction in "D" load intensity is illustrated in Fig. 3.6 and Fig. 3.8 for computing the maximum positive and negative bending moments due to "D" load. On a continuous beam with multi support the loading is as illustrated in Fig. 3.9.

(d) Dynamic Loading Allowance (DLA)

To provide the dynamic strength and vibration influence, stresses produced by the "D" loading are multiplied by an impact coefficient. DLA is applied only to the knife edge load p = 44 KN/m. Dynamic load allowance is shown in Fig. 3.10.

(e) Wind Load

Wind load given by formulas (4.1) is applied to the vertical exposed area. If consideration for the wind load on a vehicle is necessary an additional uniform horizontal line load is applied at deck level given by formulas.



b : overall width of bridges

d : depth of superstructure plus solid parapet

T_{EW} : $0.0006\ Cw\ (Vw)^2 \cdot Ab$ kN ---------(4.1)

T_{EW} : $0.0012\ Cw\ (Vw)^2 \cdot$ kN/m -----------(4.2)

Where,

Vw : design Wind Velocity

Cw : drag coefficient

Ab : equivalent side area of the bridge (m^2)

(i) Design Wind Velocity

Design wind velocity is 25m/sec in service stage and 30 m/sec in ultimate stage.

(ii) Drag Coefficient

Solid superstructure (PC Box and I-girder) is 1.25 for b/d > 6.0

(f) Breaking Force

Notwithstanding the width of the bridge, breaking and acceleration forces are given as shown in Fig. 3.11, and summarized below:

Bridges length : 0 < L < 80 m Breaking Force 250 kN

Bridges length : 80 < K < 180m Breaking Force 2.5 L + 50 kN

The longitudinal force is assumed to act bridge surface level.

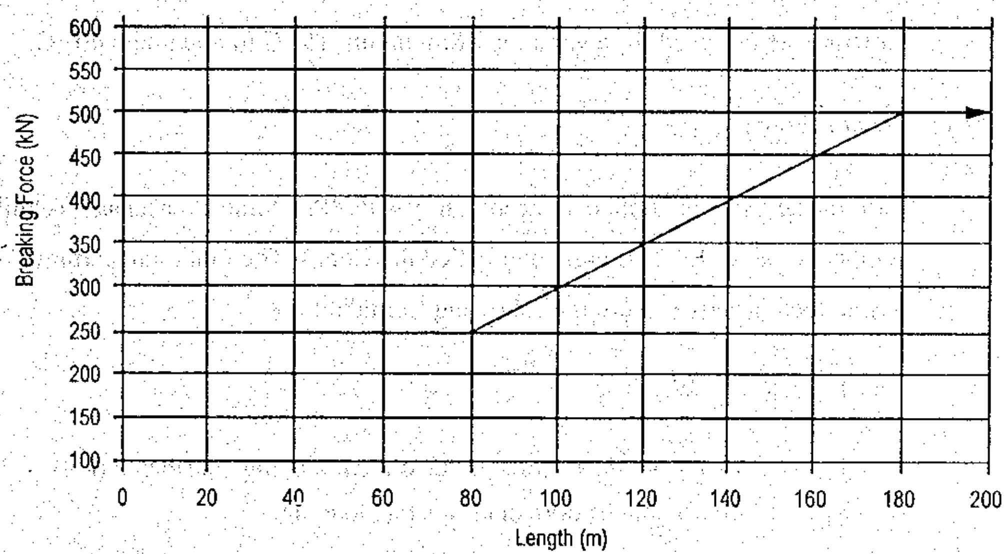


Fig. 3.11 Braking Force

(g) Vehicle Impact

The resist to collision forces on a pier due to a vehicle, a collision force of 1000 kN is applied at an angle of 10° (degree) from the direction of the center line of the road.

Design forces concrete barrier, 10 ton is obtained from the Japanese Standard. The collision force is considerate as being applied at a height of 1.80 m above roadway surface.

(h) Centrifugal Force

$$Ttr = 0.006 \cdot (V^2 / r) \cdot Tr$$

Where ,

Ttr	:	centrifugal forces acting on a section of the bridges
Tr	:	total traffic loading action on the same section of the bridges
V	:	design traffic speed (km/h)
r	:	radius of curve (m)

(2) Environmental Action

(a) Thermal Force

The assumed ambient temperature for design purpose is 30° C. Concrete structure are designed for a variation of minimum 15° C to maximum 40° C.

(b) Seismic Force

Earthquake force is applied in accordance with "Peraturan Prencanaan Teknik Jembatan Tahun 1992" (hereinafter called the Code). The minimum earthquake design load is derived from the following formula :

$$T_{eq} = K_h \cdot I \cdot W_r$$

T_{eq} : total base shear force in the direction being considered (kN)

K_h : coefficient of horizontal seismic loading

$$K_h = C \cdot S$$

where:

C : base shear coefficient for the appropriate zone, period and side condition.

S : structural type factor

I : safety factor of importance of structure

W_r : total nominal weight of structure object to seismic acceleration taken as dead load superimposed dead load (kN)

<u>Seismic Zone and Basic Shear Coefficient</u>

Semarang City is situated in Zone 4 as shown in Fig. 3.12 and the basic shear coefficient which corresponds to Zone 4 is given by the chart presented in Fig. 3.13.

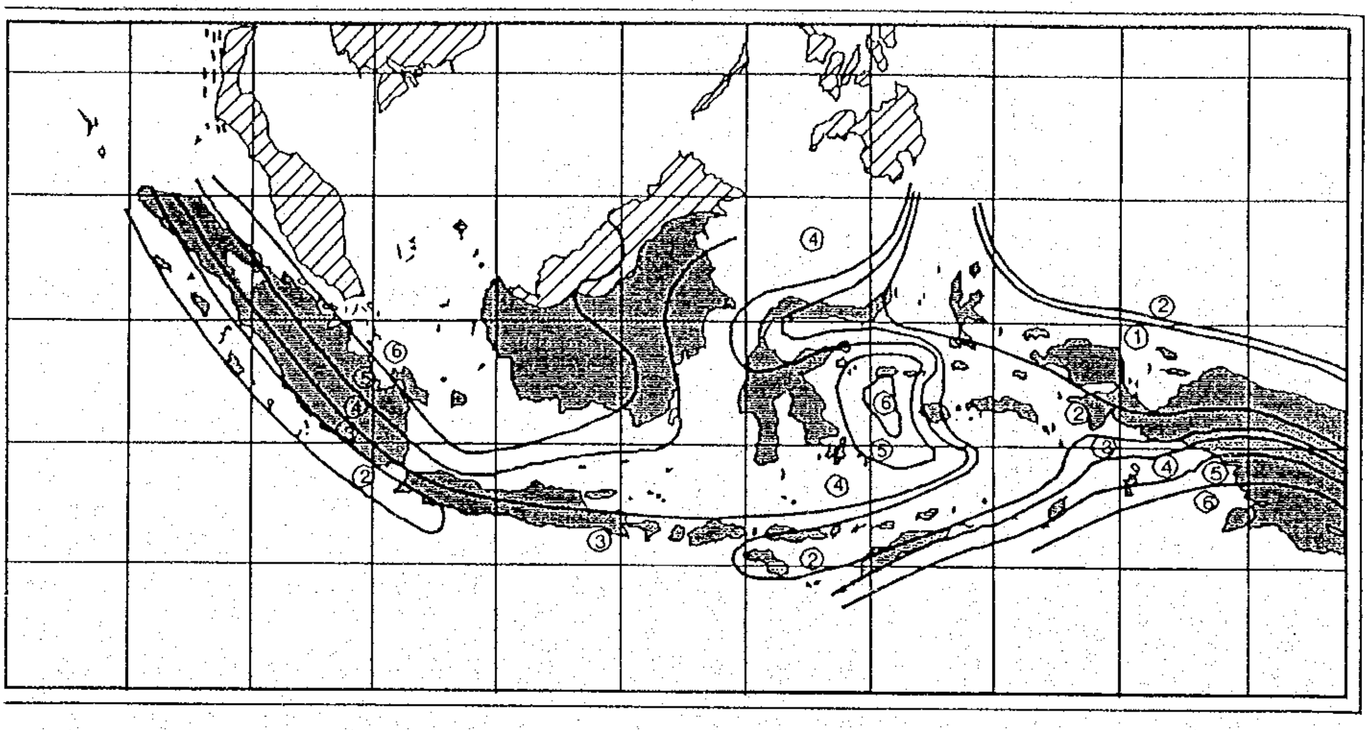


Fig. 3.12 Zones for Basic Shear Coefficient in Indonesia

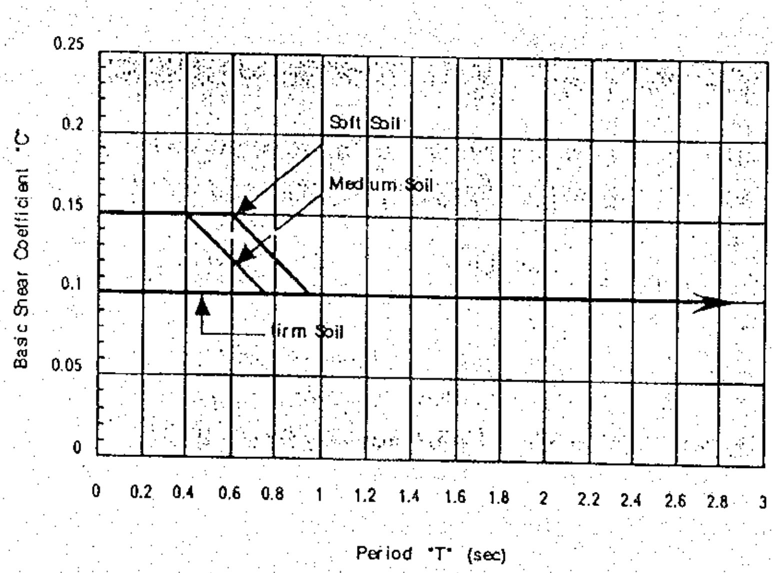


Fig. 3.13 Basic Earthquake Coefficient for Seismic Zone

3.7.2 Pavement Design Standard

The following Government pavement design standards are applied for both flexible pavement and rigid pavement:

- Guide for Flexible Pavement Design (Petunjuk Perencanaan Tebal Perkerasan Lentur Jalan Raya Dengan Metode Analisa Komponen : SKBI – 2.3.26.1987 UDC:625.73(02), Bina Marga)
- Guide for Rigid Pavement Design (Pedoman Perentuan Kaku : Beton Semen, 1985, Bina Marga)

Flexible pavement is recommended to make maximum use of the exiting flexible pavement.

3.7.3 Drainage Design Standard

Drainage facilities design is based on rainfall intensity in a year return period as stipulated in Bina Marga Standard (Petunjuk Desain Drainase Permukaan Jalan No. 008/T/BNKT/1190). To determined the flow in the road drainage facilities the modified rational formula is used and the dimensions of the road drainage facilities are determined using meaning's Formula.

CHAPTER 4 DESIGN OF BUILDING

4.1 General

4.1.1 Objective Structures

The Design Criteria will be applied to the detailed design of the following structures.

Simongan Weir Management Complex

NO	Building Name	Story	Structure
1	Operation/Management Building	2 Stories	Reinforced Concrete, Steel
2	Storage House 1and others	1 Story	Reinforced Concrete
3	Gate Control House 1and others	1 Story	Reinforced Concrete, Steel
4	Intake Gate Shed on Right, Left Bank	1 Story	Steel
5	External Works	Gardening, Others	

Jatibarang Dam

NO	Building Name	Story	Structure
1	Administration Building	3 Stories	Reinforced Concrete, Steel
2	Staff House 1(Guest house)	1 Story	Reinforced Concrete, Steel
3	Staff House 2-4	1 Story	Reinforced Concrete, Steel
4	Mushola	1 Story	Reinforced Concrete, Steel
5	Hydropower Station	2 Stories	Reinforced Concrete, Steel
6	Garage	1 Story	Steel
7	Guard House	1 Story	Reinforced Concrete, Steel
8	External works	Gardening, Others	

Pumping Station Complex

1	Pump Control Building	1 Story	Reinforced Concrete
2	Management Office and others	1 Story	Reinforced Concrete, Wood
3	External Works	Gardening, Others	

4.1.2 Code and standards

(1) The design and computation are based on internationally accepted codes, standards as well as conformity with Indonesian codes, standards and practice.

The following codes and standards are principally used in establishing design conditions of each structure.

1) Indonesia loading code for building 1987
2) Indonesia seismic code for building 1987
3) Indonesia reinforcement concrete code 1991
4) Steel Indonesia building plan code (PPBBI-1987)
5) Indonesia timber construction regulation (PKKI-1961)
6) Standard of Indonesian Industry (SII)

(2) In addition, the following standards/specifications are used to supplement the design codes/standards mentioned above.

1) Building code requirements for reinforced concrete (ACI318-83) 1987
2) American Society for Testing and Materials (ASTEM)

4.2 Structural Design

4.2.1 Construction Materials and Their Properties

The standards for construction materials are the same as civil works.

4.2.2 Design Load

According to the Indonesian Loading code for building 1987, the loading at structure depends on the combination of loads such as dead load, live load, wind load, seismic load, and temperature factor. For the seismic load and wind load named as temporary load, one of which of the greater value shall be chosen. So the loading combination (U) is as follows:

U = DL + LL + W or

U = DL + LL + E

Where,

U	: Loading Combination
DL	: Dead Load
LL	: Live Load
W	: Wind Load
E	: Seismic Load

(1) Dead Load

Dead load is self-weight of a structure.

<u>Material</u>	<u>Unit weights</u>
Steel	: 7850 $^{kg}/_{m}{}^{3}$
Reinforced Concrete	: 2400 $^{kg}/_{m}{}^{3}$

(2) Live Load

Live load which is taken from "Indonesia loading code for building 1987"

(a) Live load of each building

Roof and Canopy, House	: 100 $^{kg}/_{m}{}^{2}$
Office	: 250 $^{kg}/_{m}{}^{2}$
Ware house	: 400 $^{kg}/_{m}{}^{2}$
Stairs, Corridor and Lavatory	: 300 $^{kg}/_{m}{}^{2}$

In case of some heavy loads are expected, the applied load should be estimated individually.

(b) Reduction coefficient of live load for seismic load

<u>Buildings</u>	<u>For seismic load</u>
Office, House	: 0.30
Ware house, files room	: 0.80
Stair, corridor, lavatory	: 0.50
Roof, canopy, eaves	: 0.50

(c) Reducing of live load for seismic load (kg/m^2)

Buildings	Basic live load	Reducing of live load
Roof, House	100	50
Office	250	75
Ware house, files room	400	320
Stair, corridor, lavatory	300	150

(3) Seismic load

The seismic load is taken from "Indonesia Seismic Code for Building 1987". According to the seismic code. Semarang is located in IV of Seismic Zone.

(a) Basic shearing horizontal force

$V = Cd * Wt$ (t)

Where,

$Cd = C \cdot I \cdot K$

Wt : Total weight of dead load and reducing of live load

C : Basic shear coefficient $C = 0{,}56$

I : Importance factor for Office building $I = 1.5$

K : Structure type factor reinforced concrete $K = 1.0$

(b) Distribution of basic shearing force along the height of building

$Fi = V * (Wi * hi) / (Wi * hi)$

Where,

Fi : Shearing force on level i (t)

Hi : Height to level i from 1st floor level (m)

Wi : Total weight on level i (t)

(4) Wind load

The wind load is taken from " Indonesian Loading for Code Building 1987".

$P = V^2 / 16$

Where,

P : Velocity pressure (kg/m^2)

V : Wind velocity (m/sec)

40m/sec is taken in Semarang

(5) Combination of various loads.

In Semarang, the seismic load will exceed the wind load. Therefore, the required strength (U) of building by considering safety factor is as follow:

- Permanent load : U = 1.2 DL + 1.6 LL
- Temporary load with seismic load : U = 1.05 (DL + LR ± E)
- Temporary load with temperature factor : U = 0.75 · (1.2DL+1.2T+1.6 LL)

Where:

DL : Dead load

LL : Live load

LR : Reduced live load

W : Wind load

E : Seismic load

T : Temperature effect

Wind loads are considered as temporary load for design of roof structure.

(6) Temperature Factor

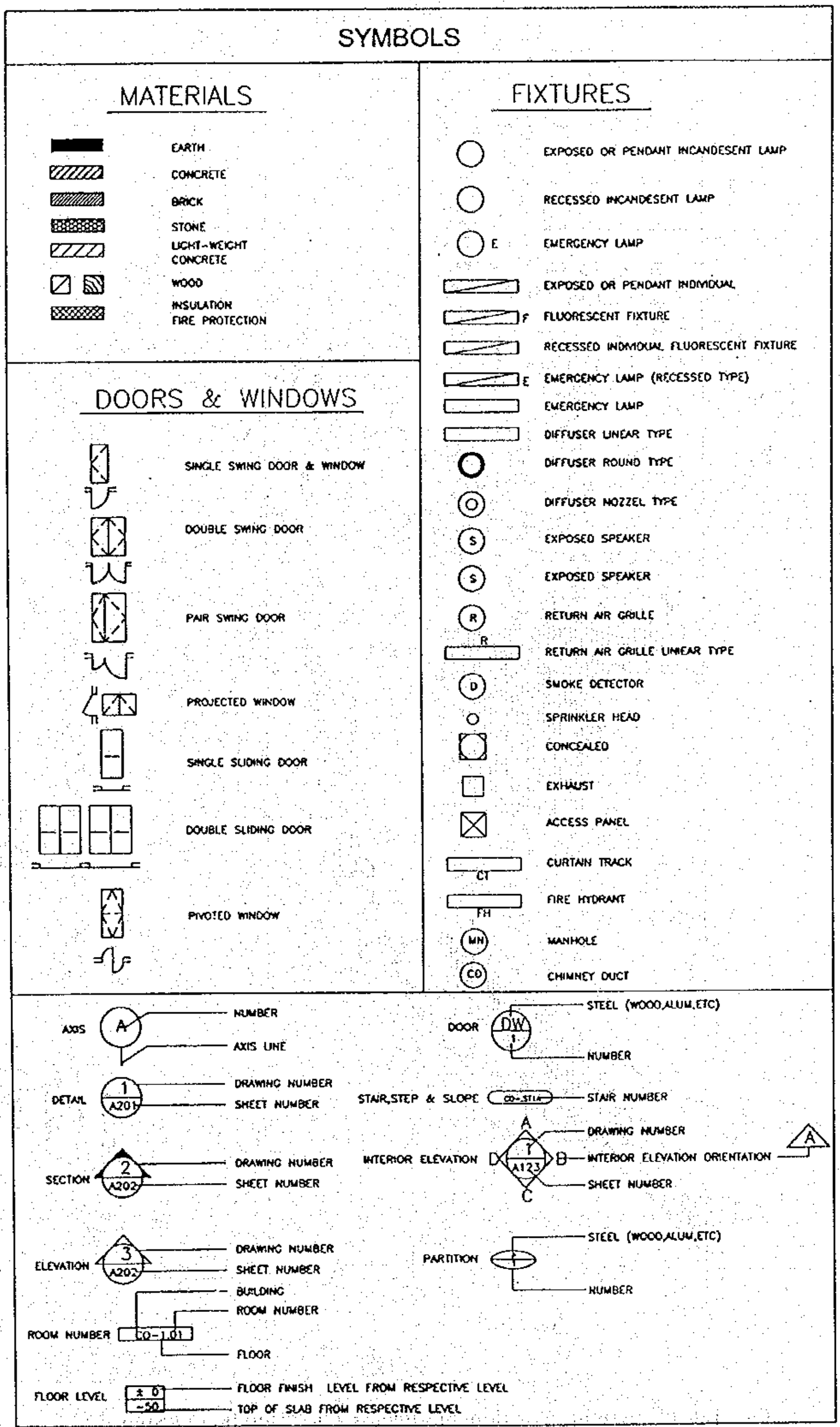
Based on the "Indonesia Loading Code 1987", thermal coefficient is 1.08E-5 (/°C).

4.3 Abbreviation and Legend

(1) Abbreviation

ABV.	ABOVE
A/C	AIR CONDITIONING
ACO.TILE	ACOUSTICAL TILE
ADJ.	ADJUSTABLE
ALT.	ALTERNATIVE
A.L.F	ALUMINIUM FOIL
ALUM.	ALUMINIUM
ANCH.	ANCHOR
APRX.	APPROXIMATELY
A.F.P	ACCES(FLOOR PANEL)
ARCH.	ARCHITECTURAL
ASPH.	ASPHALT
AX.L	AXIS LINE
L	ANGLE
O	AT
B	BASE
B.B.	BASEBOARD
B.D	BOARD
BLDG	BUILDING
B.M	BENCH MARK
BTWN	BETWEEN
CAB.	CABINET
CPT.	CARPET
CEMT.	CEMENT MORTAR TROWEL
CLG.	CEILING
C.H	CEILING HEIGHT
C.C	CENTRE COUNTER
C.M.T	CERAMIC TILE
C.A	COLOR ANODIZED
COL.	COLUMN
COR.	CORRIDOR
CONT.	CONTINUOUS
CEMNT.C.H	CEMENT MORTAR TROWEL W / COLOUR HARDENER
DIA.	DIAMETER
DIM.	DIMENSION
DN.	DOWN
DR.	DOOR
D.S	DUCT SPACE
DWG.	DRAWING
E.	EAST
EA.	EACH
ELEC.	LECTRICITY
ELV.	ELEVATOR
E.P.S	ELECTRIC PIPE SHAFT
EQ.	EQUAL
EXH.	EXHAUST
EXPU.	EXPOSED
E.J	EXPANSION JOINT
EXT.	EXTERIOR
EQUIP.	EQUIPMENT
E.W.C	EXECTIVE WATER CLOSET
E.R.C	EPOXY RESIN COATING
FO.	FLOOR
FIB.	FIBRE
(F)	FEMALE
FIN.	FINISH
F.DMP.	FIRE DAMPER
F.H	FIRE HYDRANT
F.PRTC.	FIRE PROTECTION
F.D	FLOOR DRAIN
FL	FLOOR LEVEL
FTG	FOOOTING
FD	FOUNDATION
F.	FIBRE
FCB	FIBRE CEMENT BOARD
GLS	GLASS
GALV.	GALVANIZED
G.I	GALVANIZED IRON
GFL.	GROUND FLOOR LEVEL
G.L.	GROUND LEVEL
G.C.TILE	GLAZED CERAMIC TILE
G.F	GROUND FLOOR
GYP.	GYPSUM
GRL.	GRILL
G.P.B	GYPSUM PLASTER BOARD
G.P.T	GYPSUM PLASTER TROWEL
GB	GLASS BLOCK
H	HEIGHT
HDWD.	HARDWOOD
HOZL	HORIZONTAL
H.B	HOOK BATTEN W/S.P
I.D	INSIDE DIAMETER
INSUL	INSULATION
INT.	INTERIOR
JT	JOINT
L	LENGT
LAM	LAMINATED
LAD.	LADDER
(M)	MALE
MACH	MACHINE
MALT.	MATERIAL
MECH.	MECHANICAL
MAX.	MAXIMUM
MBL	MARBLE
MET	METAL
MIN.	MINIMUM
MIR.	MIRROR
M.A.TILE	MINERAL ACOUSTICAL TILE
MLDG	MOLDING
MDF	MAIN DISTRIBUTOR FRAME
N	NORTH
NO.	NUMBER
N.I.C	NOT IN CONTRACT
N.T.S	NOT TO SCALE
O.C	ON.CENTRE
O.D	OUTSIDE DIAMETER
OH	OVERHEAD
P	PAINT
P.C	PRECAST CONCRETE
PL	PLATE
PLAS.	PLASTER
PLY'D	PLYWOOD
POL	POLISHED
F.PRTC.	FIRE PROTECTION
PORC.T	PORCELAIN TILE
P.S.	PIPE SHAFT
PTN	PARTITION
P.V.C	POLY VINYL CHLORIDE
PHG.	PENTHOUSE FLOOR LEVEL
PHR.	PENTHOUSE ROOF
R.C	REINFORCED CONCRETE
R.D	ROOF DRAIN
R.F	ROOF FLOOR
RM	ROOM
RS.	RESILIENT
R.L	RAIN LEADER
S	SCALE
SD	STEEL DOOR
SEC.	SECTION
SHT.	SHEET
SPECS	SPECIFICATIONS
SEC.	SECTION
SQ.	SQUARE
SS	STAINLESS STEEL
SSD	STAINLESS STEEL DOOR
SSW	STAINLESS STEEL WINDOW
ST.	STAIRCASE
STL.	STEEL
STOR.	STORAGE
STRUCT.	STRUCTURAL
SUSP.	SUSPENDER
SW.	STEEL WINDOW
SP.W.C	SPRAYED WHITE CEMENT
STN.	STONE
T	THICK
TEL.	TELEPHONE
T.V.	TELEVISION
TERR.	TERRAZZO
T.F	TROWEL FINISH
TYP.	TYPICAL
T.B.	TERRAZO BLOCK
UG.C.T.	UNGLAZED CERAMIC TILE
U.N.O	UNLESS NOTED OTHER WHISE
VERT.	VERTICAL
V.A.T	VINYL ASBESTOS TILE
V.E.P	VINYL EMULSION PAINT
V.B	VENT BLOCK
W	WIDTH
WD	WOODEN DOOR
W.GL	WIRE GLASS
W.C	WATER CLOSET
W.P	WATERPROOFING
WT.	WEIGHT
WDW	WINDOW
WD	WOOD
WL	WALL

(2) Symbols


SYMBOLS
MATERIALS
EARTH
CONCRETE
BRICK
STONE
LIGHT-WEIGHT CONCRETE
WOOD
INSULATION FIRE PROTECTION
FIXTURES
EXPOSED OR PENDANT INCANDESCENT LAMP
RECESSED INCANDESENT LAMP
E
EMERGENCY LAMP
EXPOSED OR PENDANT INDIVIDUAL FLUORESCENT FIXTURE
F
RECESSED INDIVIDUAL FLUORESCENT FIXTURE
E
EMERGENCY LAMP (RECESSED TYPE)
EMERGENCY LAMP
DIFFUSER LINEAR TYPE
DIFFUSER ROUND TYPE
DIFFUSER NOZZEL TYPE
S
EXPOSED SPEAKER
S
EXPOSED SPEAKER
R
RETURN AIR GRILLE
R
RETURN AIR GRILLE LINEAR TYPE
D
SMOKE DETECTOR
SPRINKLER HEAD
CONCEALED
EXHAUST
ACCESS PANEL
CT
CURTAIN TRACK
FH
FIRE HYDRANT
MN
MANHOLE
CO
CHIMNEY DUCT
DOORS & WINDOWS
SINGLE SWING DOOR & WINDOW
DOUBLE SWING DOOR
PAIR SWING DOOR
PROJECTED WINDOW
SINGLE SLIDING DOOR
DOUBLE SLIDING DOOR
PIVOTED WINDOW
AXIS
A
NUMBER
AXIS LINE
DETAIL
1
A201
DRAWING NUMBER
SHEET NUMBER
SECTION
2
A202
DRAWING NUMBER
SHEET NUMBER
ELEVATION
3
A202
DRAWING NUMBER
SHEET NUMBER
ROOM NUMBER
CO-1.01
BUILDING
ROOM NUMBER
FLOOR
FLOOR LEVEL
± 0
-50
FLOOR FINISH LEVEL FROM RESPECTIVE LEVEL
TOP OF SLAB FROM RESPECTIVE LEVEL
DOOR
DW
1
STEEL (WOOD,ALUM,ETC)
NUMBER
STAIR,STEP & SLOPE
STAIR NUMBER
INTERIOR ELEVATION
A
B
C
D
1
A123
DRAWING NUMBER
INTERIOR ELEVATION ORIENTATION
SHEET NUMBER
PARTITION
STEEL (WOOD,ALUM,ETC)
NUMBER

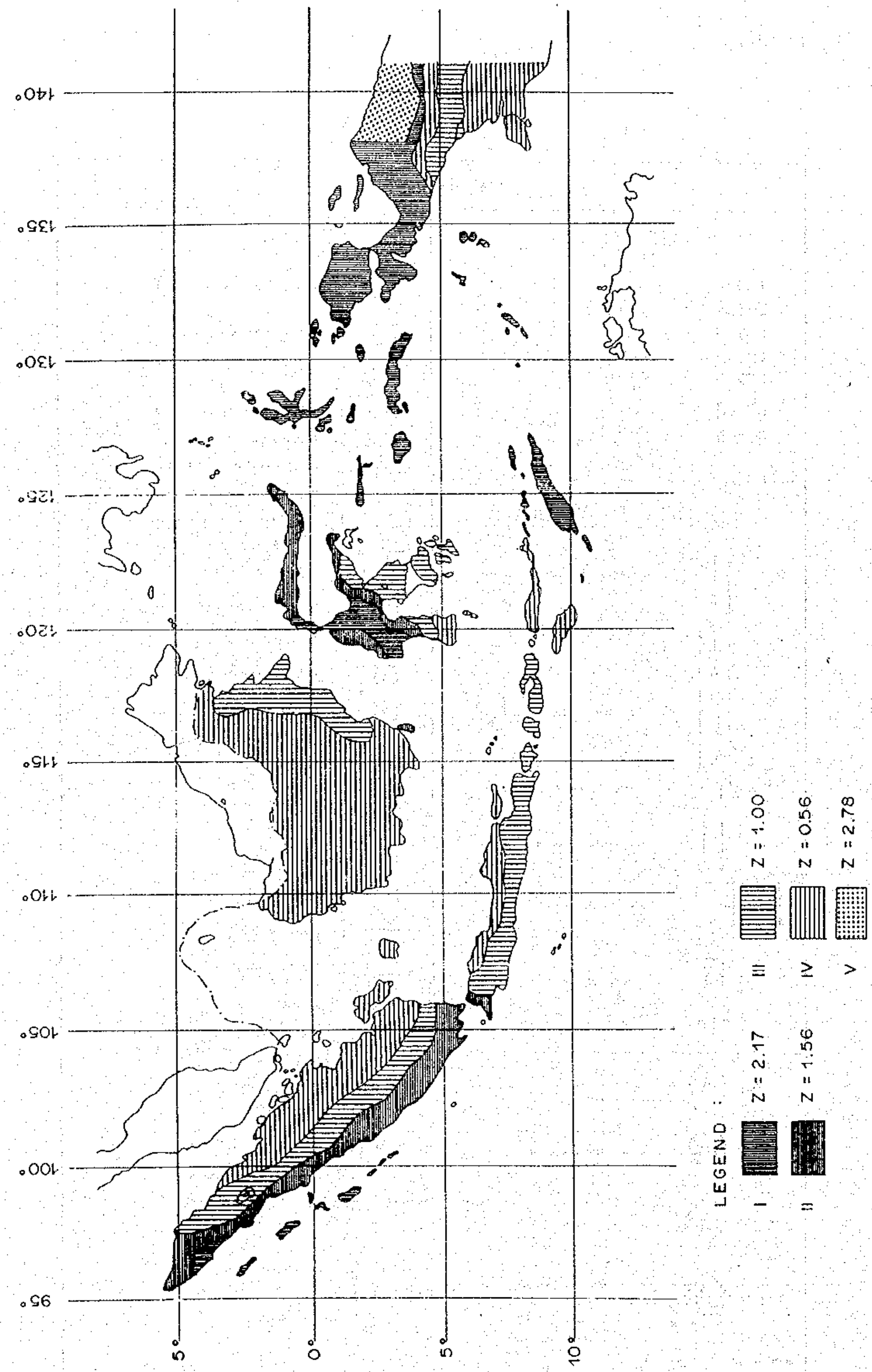


Fig. 4-1 Geographic Position and Factor Z for Building Design

CHAPTER 5 DRAWING STANDARD

5.1 General Standard

5.1.1 General

This drafting standard aims to standardize the drawings to be prepared for the detailed design for "Flood Control, Urban Drainage and Water Resources Development in Semarang". In preparing this drafting standard, "Irrigation Design Standard, Volume : Drawing Standard" is used.

(1) Drawing sizes

In principle, the sheet size will conform to size A1(Width=594 mm x Length=841 mm). In case that the topographic maps such as river plans are used as the design drawing, the sheet size A0 can be applied. In this case, the width of sheet will be the same as that of the sheet A1, and then the length of sheet varies with the length of 841mm or more. The typical layout for A1 size drawing sheet is shown in Fig. 5.1.

(2) Title blocks

The title block as shown in Fig. 5.2 will be arranged at the right and bottom corner of drawings basically.

(3) Line and letter

The line for drawing will be used adequately in accordance with the classification of line as shown in Fig. 5.3. The lettering for drawing will comply with the standard as shown in Fig. 5.4.

(4) Notation

All notations (Note, General Note, Specific Note, Local Note and so on) necessary for design and construction of structures written on the drawing will be mentioned on the drawing. These notes are mentioned on the designated area on the left and bottom part of sheet as shown in Fig. 5.1. Notes for general plan and profile drawings will be placed in the lower part of drawing.

5.1.2 Dimensions

The dimension will be expressed in millimeter (mm) of metric system unless otherwise noted. For the description of dimension, the following care shall be taken.

(1) Unit of dimensions

Unless otherwise specified, the dimensions will be as follows;

Type of Dimensions	Unit	Example
Length	millimeter (mm)	12,300
Elevation	meter (m)	EL. 123.45
Angle	degree, minute, second	12° 34' 56"
Gradient	% or ratio at	5% or 1 : 2.0
Coordinates	meter	X=550,000.000,
Y=31,000.000		

(2) Description of dimensions

Description of dimensions will comply with the standard as shown in Fig. 5.5.

5.1.3 Abbreviation and Symbol

(1) Abbreviation

The abbreviation to be used for drawing will be as described in Table 5.1.

(2) Symbol

The symbol to be used for description of materials and for mapping will be shown in Figs. 5.6 , 5.7 and Fig. 5.8, respectively.

(3) Indication of reinforcing bar

The indication of reinforcing bars shall follow the Indonesian Concrete Standard 1971 (PB I 71), further more the descriptions of kind, diameter and spacing of reinforcing bars are presented as follows :

Example

ϕ 16 @ 300

where,	ϕ	:	round reinforcing bar
	16	:	nominal diameter is 16 mm
	@ 300	:	spacing is 300 mm

D16 @ 300

where,	D	:	deformed reinforcing bar
	16	:	nominal diameter is 16 mm
	@ 300	:	spacing is 300 mm

5.2 Drawing for Structural Design

5.2.1 Kinds of Drawings

The drawings are classified into the following three kinds.

(1) General Plan, Profile, Channel Cross Sections and layout of Structures

Plan of rivers/drainage channels, channel profile, cross sections of channel, location maps, and general layout of major structures are included in this category. This kind of drawing will indicate the river improvement plan, longitudinal profile and cross sections of channel, location of structures and principal features of construction works for major structures.

(2) Structural drawings

Plan, profile and section of structures are included in this category. This kind of drawings will indicate the principal dimensions of structures.

(3) Detail drawings

Drawings for details of structures and drawings for reinforcing bar arrangement are included in this category.

Typical scales for the drawings are summarized in Table 5.2.

5.2.2 Arrangement of Drawings

(1) Orientation

For topographical and location maps the north direction will be indicated in the drawing. Drawings showing plan of river/drainage channel will be oriented as the flow direction is situated from the right side to the left side of drawings. Orientation of longitudinal profiles of river/drainage channel is made in such a manner as the upstream side of stream is situated on the right side of drawing sheet. Other drawings will be oriented properly in consideration of the consistency with the orientation in relevant maps or drawings.

(2) Arrangement of figures in drawing

In case that plural figures are to be presented in one drawing sheet, principal view which shows main feature of structure will be arranged at the top and the left corner of drawings. The secondary view which shows the side view or sectional view of structures will be arranged at the right side of or below the principal view. The views or sections explaining the specific details structure will be arranged at the right side of or below the principal and secondary views.

TABLE 5.1 (1/2) GLOSSARY OF TERMS AND ABBREVIATION

(1) LOCAL ADMINISTRATION AND ORGANIZATION

Kab. (Kabupaten)	: Regency	Kali, Sungai	: River
Kec. (Kecamatan)	: Township	Rawa	: Swamp
Desa	: Village	Laut	: Sea
Kp. (Kampung)	: Community	Gunung	: Mountain

(2) ABBREVIATION OF MEASURES

<u>Length</u>

mm	: millimeter
cm	: centimeter
m	: meter
km	: kilometer

<u>Weight</u>

g	: gram
kg	: kilogram
t	: ton

<u>Area</u>

cm^2	: square centimeter
m^2	: square meter
ha	: hectare = 10^4 m^2
km^2	: square kilometer

<u>Force</u>

kgf	: kilogram force
N	: newton
	(1kgf=9.80665N)

<u>Volume</u>

cm^3	: cubic centimeter
m^3	: cubic meter
lit, l	: liter = 1,000 cm^3
mcm	: million cubic meter

<u>Stress</u>

kgf/cm^2	: kilogram force per square centimeter
t/m^2	ton per square meter

<u>Discharge</u>

m^3/s	: cubic meter per second
l/s	: liter per second
m^3/d	: cubic meter per day
mcm/y	: million cubic meter per year

<u>Pressure</u>

P_a	: pascal
kP_a	: kilo-pascal
MP_a	: mega-pascal
	(kgf/cm^2=9.80665 × 10^4 P_a

<u>Other Measures</u>

kV	: kilovolt	℃	: degree centigrade
kW	: kilowatt	%	: percentage
MW	: megawatt = 1,000 kW	no/no s	: number / numbers
kVA	: kilovolt ampere	EL m	: elevation meter
Hz	: hertz		

TABLE 5.1(2/2) GLOSSARY OF TERMS AND ABBREVIATION

(3) OTHER ABBREVIATION

BC	= Beginning Point of Curve
BM	= Bench Mark
BOTT	= Bottom
BP	= Beginning Point
BR.	= Bridge
BT	= Bent
CJ	= Construction Joint
L	= Center Line
CL	= Curve Length
CMP	= Corrugated Metal Pipe
CONC	= Concrete
CTC	= Center to Center
C-Bx	= Culvert Box
C-P	= Culvert Pipe
D	= Diameter of Deformed Bar
DFWL	= Design Flood Water Level
DIAG	= Diagonal Bar
DL	= Datum Line
DHWL	= Design High Water Level
DWG	= Drawing
EL	= Elevation
EC	= Ending Point of Curve
EP	= Ending Point
° E	= East Longitude
EF	= Each Face
EXP.J	= Expansion Joint
FF	= Far Face
FIG.	= Figure
FP-MG	= Foot Protection, Mat Gabion
GALV	= Galvanized
GH	= Ground Height
GR	=Guard Rail
HWL	= High Water Level
HHWL	= Highest High Water Level
I	= I- beam
IF	= Inside Face
IA	= Intersection Angle
ID	= Inside Diameter
IF	= Inside Face
IP	= Intersection Point
i	= Grade
L	= Length
LLWL	= Lowest Low Water Level
LWL	= Low Water Level
MAX	= Maximum
MIN	= Minimum
MSL	= Mean Sea Level
N	= North
ND	= Naked Ditch
NF	= Near Face
NIC	= Not Including in This Contract
NWL	= Normal Water Level
No.	= Number
° N	= North Latitude
OF	= Outside Face
OD	= Outside Diameter
PC	= Prestressed Concrete
PL	= Plain Bar
PH	= Proposed Height
PMF	= Probable Maximum Flood
PVC	= Polivinyl Chloride
P	= Plate
RC	= Reinforced Concrete
ROW	= Right of Way
RW-SM	= Retaining Wall, Stone Masonry
R	= Radius
SL	= Secant Length
SP	= Spiral
SPD	= Stone Pitching Ditch
SP-SP	= Slope Protection, Stone Pitching
STA	= Station
STD	= Standard
STIR	= Stirrup
STR	= Straight
SWL	= Surcharge Water Level
TF	= Top Face
TL	= Tangent Length
TYP	= Typical
VCL	= Vertical Curve Length
WP	= Working Point
WS	= Water Stop
O	= Diameter of Round Bar, Pipe
a,x	= Repetition of Same Spacing°
° ’’’’	= Angle (degree, minute, second)

TABLE 5.2 STANDARD SCALE OF DRAWING

Kinds of Drawings	Scale
River / Drainage Channel, Weir, Pumping Station and related structures	
- General plan	1/10,000, 1/5,000, 1/2,000
- Plan of river/ drainage channel	1/2,000, 1/1,000
- Cross section of river/ drainage channel	Horizontal : 1/200, Vertical : 1/100
- Profile of river/drainage channel	H : 1/10,000, 1/5,000, Vertical : 1/100
- Structural general, plan, section	1/500, 1/200, 1/100, 1/50
- Structural detail	1/50, 1/20, 1/10, 1/5
Dam, diversion works, spillway, waterway and related structures	
- General plan	1/10,000, 1/5,000, 1/2,000
- Site plan	1/2,000, 1/1,000
- Plan, section, profile	1/2,000, 1/1,000
- Structural general, plan, section	1/500, 1/200, 1/100, 1/50
- Structural detail	1/50, 1/20, 1/10, 1/5, 1/2
Road	
Site plan	1/20,000
Detail design; plan	1/1,000
Detail; profile	v:1/100, H:1/1,000
Detail; cross section	1/200
Concrete structures and steel structures	
Plan, view and profile	(1/600), 1/500, (1/400), (1/300), 1/200, 1/100
Structural general	1/200, 1/100, 1/50
Structural element	(1/60), 1/50, (1/40), 1/30, 1/20
Details	1/20, 1/10, 1/5, 1/2, 1/1

Note : Scales mentioned in brackets or other scales which are not mentioned above may only be used for technical reasons.

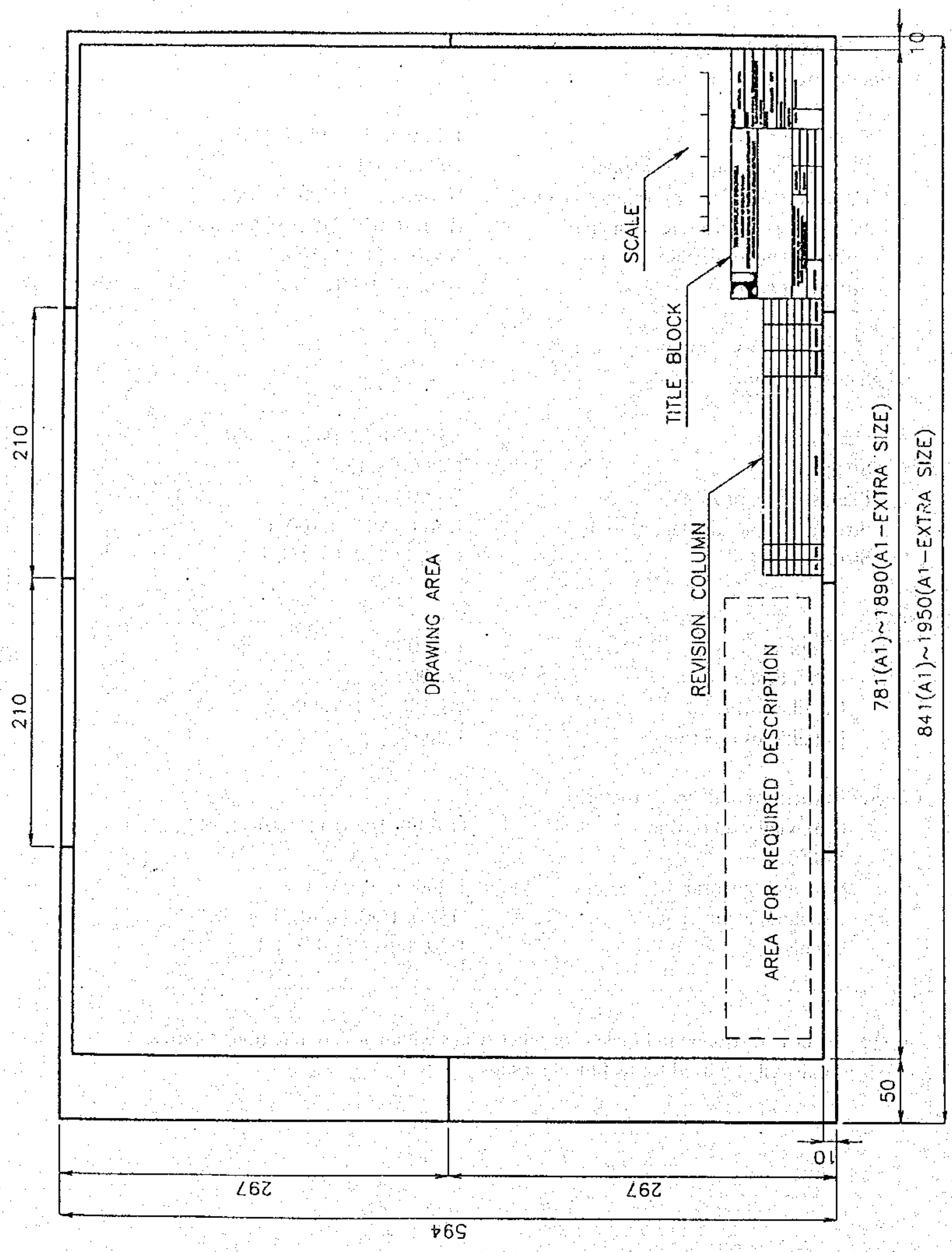


Fig. 5.1 TYPICAL LAYOUT OF DRAWING SHEET

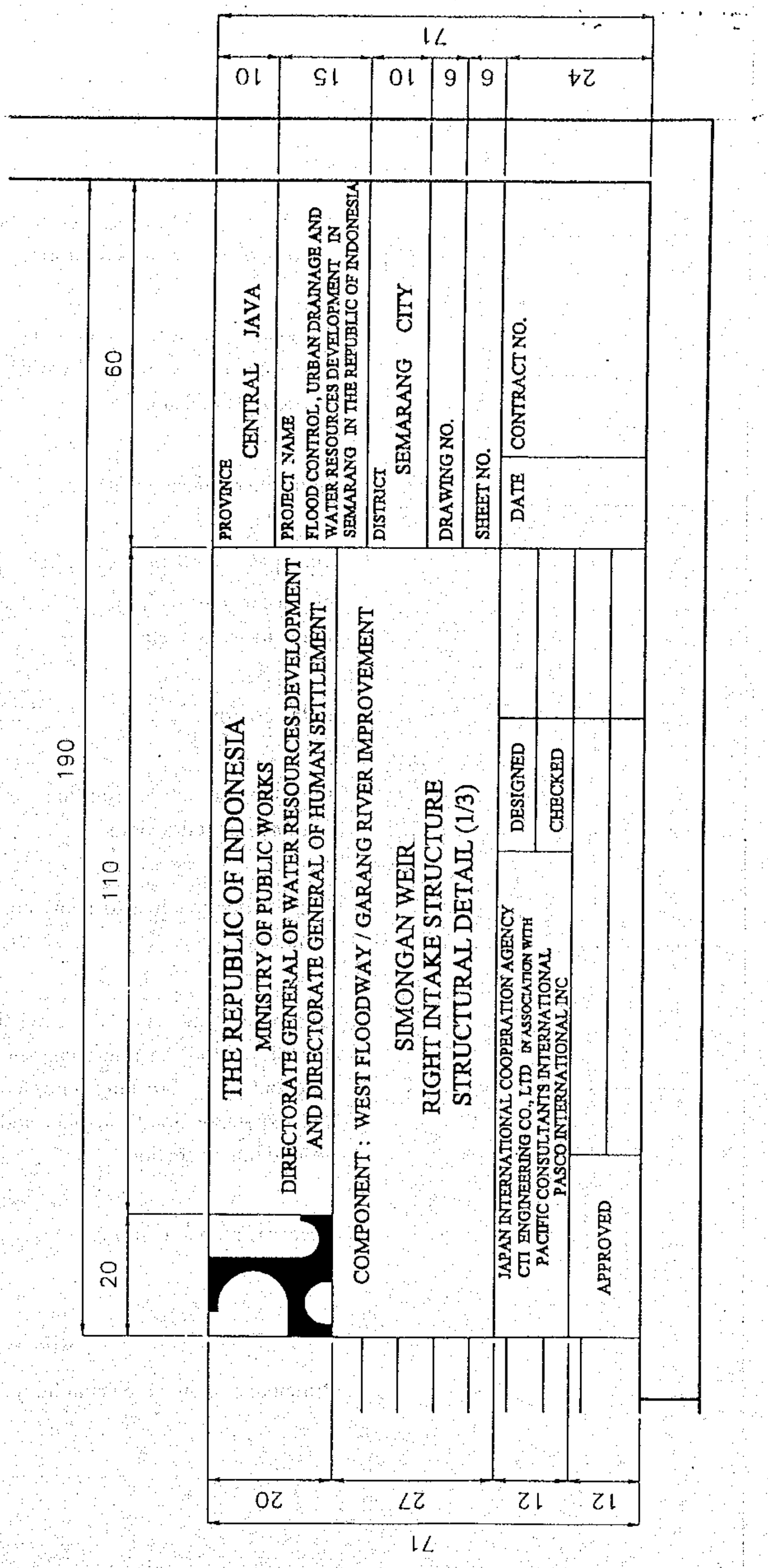


Fig. 5.2 STANDARD OF TITLE BLOCK (SCALE 1:1)

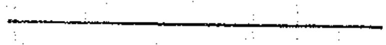
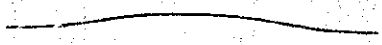
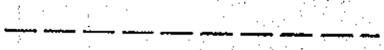
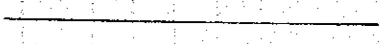
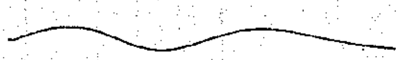
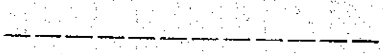
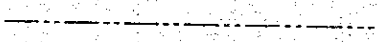
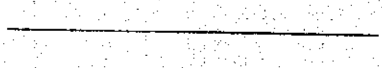
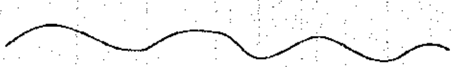
Thickness (mm)	Line	Application
0.4		Outline of structures in section, profile and section plan as well as reinforcing bars.
0.4		Boundary between rock and concrete structures, as well as excavated line in sections. (Freehand line)
0.4		Invisible reinforcing bars
0.2		Visible lines of structures in plan, elevation, etc., contraction and expansion joints in section, etc.
0.2		Index contour
0.2		Invisible structure outline except in reinforcement drawings.
0.2		Out of function line to show construction boundary.
0.1		Dimension line and its extension line, concrete outline in reinforcement drawing, blockout line, breaking line, contraction and expansion joints in plan and original ground line in section.
0.1		Leader (Freehand line)
0.1		Principal contour (Freehand line)

Fig. 5.3(1/2) LINES AND APPLICATIONS

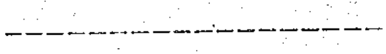
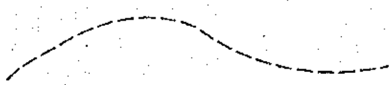
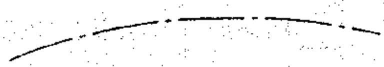
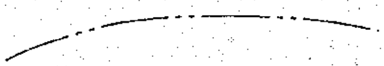
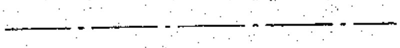
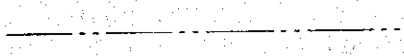
Thickness (mm)	Line	Application
0.1		Invisible structure outline in reinforcement drawing.
0.1		Original contours after excavation, if required (Freehand line)
0.1		Assumed hard rock line, if required (Freehand line)
0.1		Assumed soft rock line, if required (Freehand line)
0.1		Center line
0.1		Imaginary line, match line, construction joint line and concrete placing lift in section, (Match line shows the dividing section of along protruding feature in drawing sheet).

Fig. 5.3(2/2) LINES AND APPLICATIONS

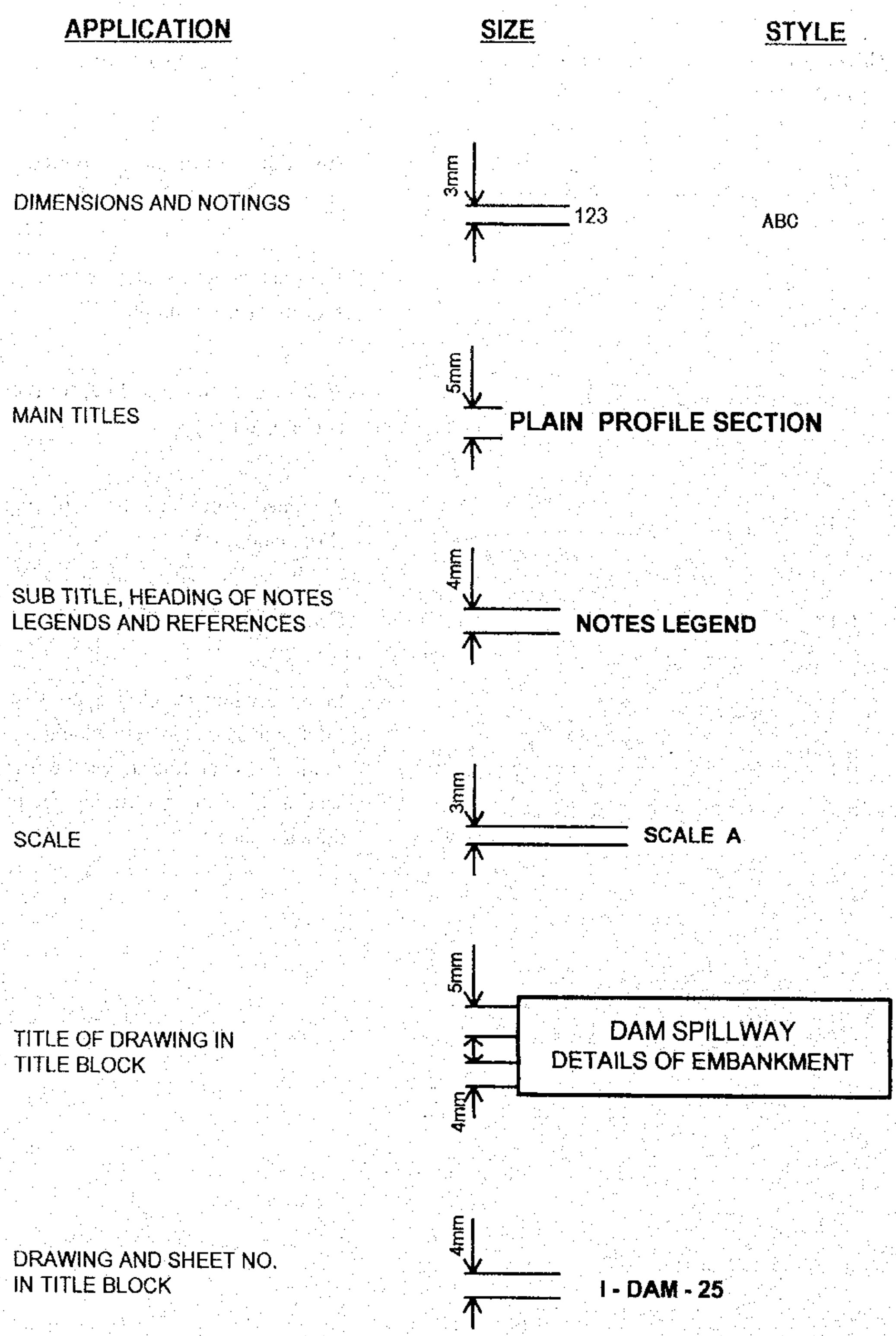
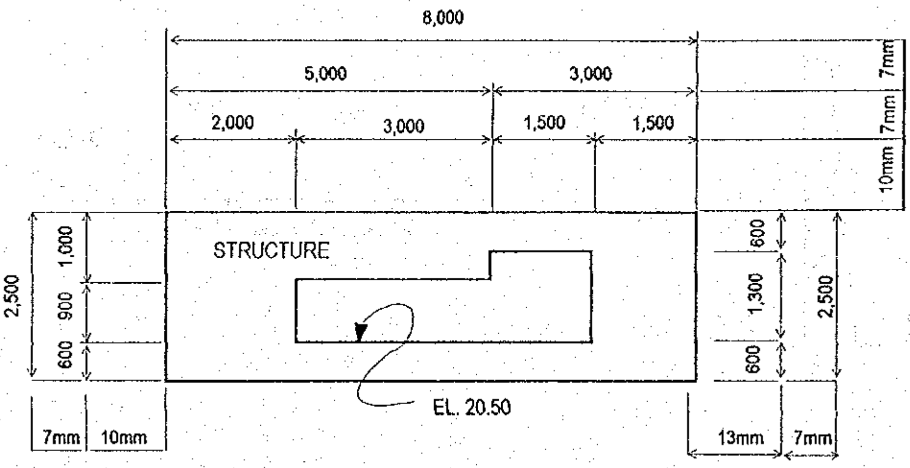
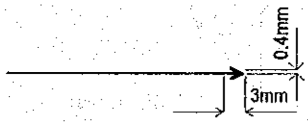


Fig. 5.4 STANDARD OF LETTERING

(1) DIMENSION AND DIMENSION LINE

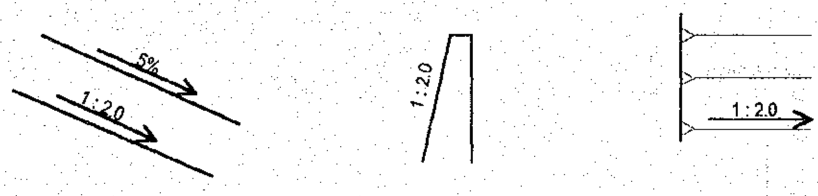


(2) ARROWHEAD



(3) LEADER

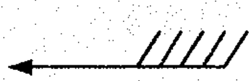
(4) SLOPE



(5) DIRECTION

FLOW DIRECTION

NORTH DIRECTION



(6) SCALE

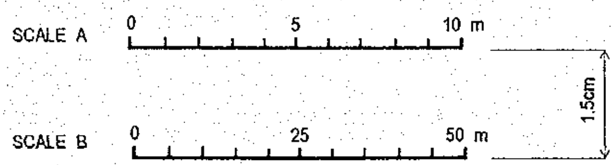
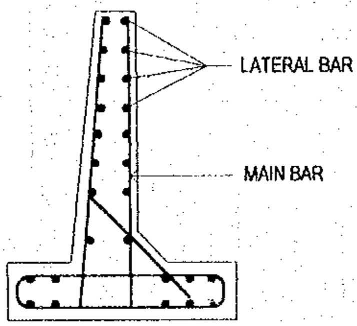
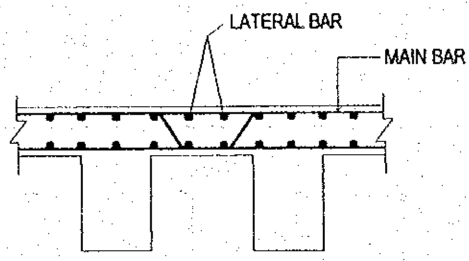


Fig. 5.5(1/2) STANDARD DESCRIPTION

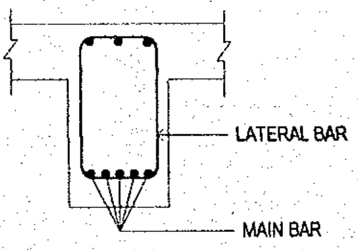
BAR ARRANGEMENT



WALL



SLAB



BEAM

SECTION ARROWHEAD

Fig. 5.5(2/2) STANDARD DESCRIPTION

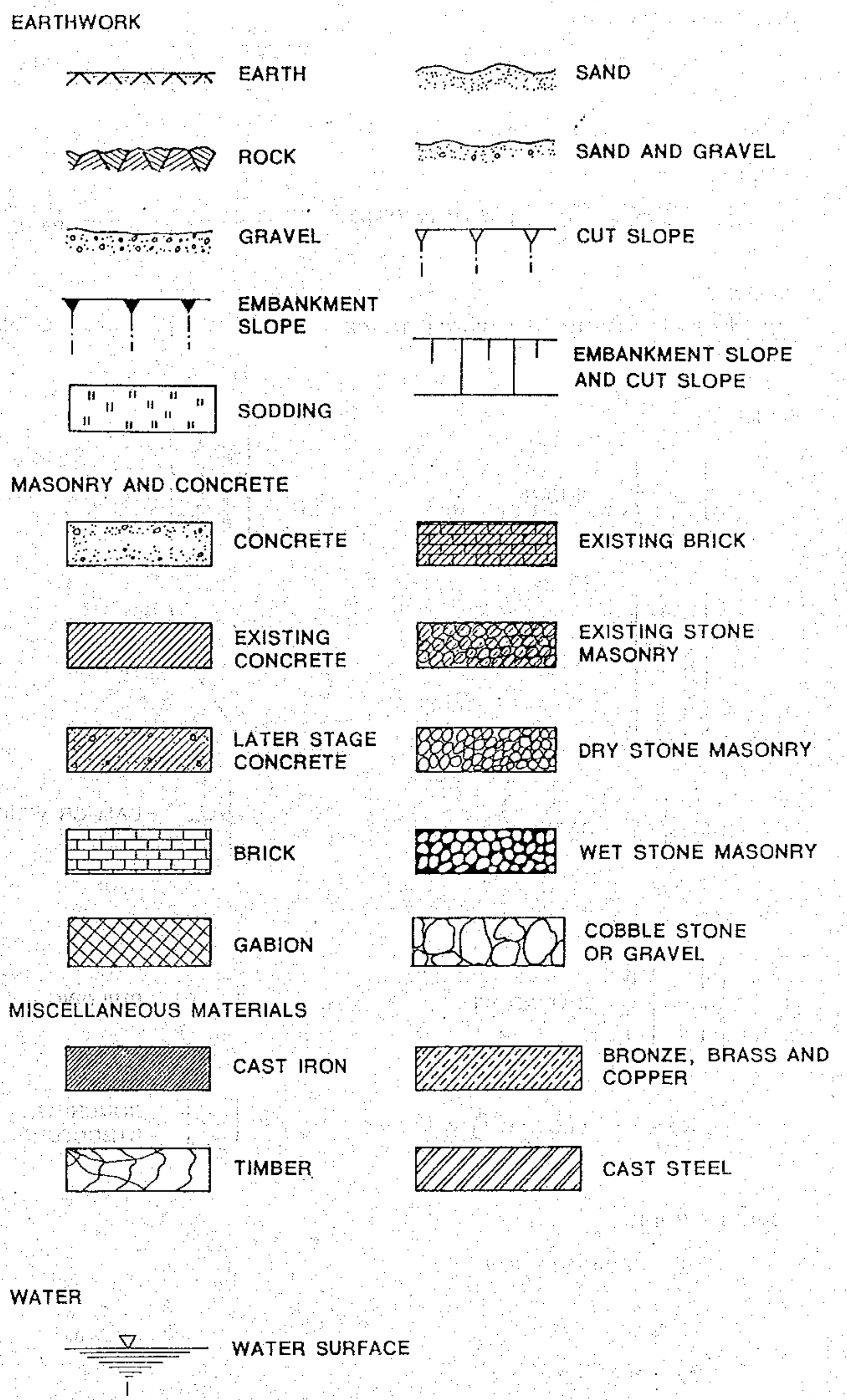


Fig. 5.6 SYMBOLS FOR DRAWING

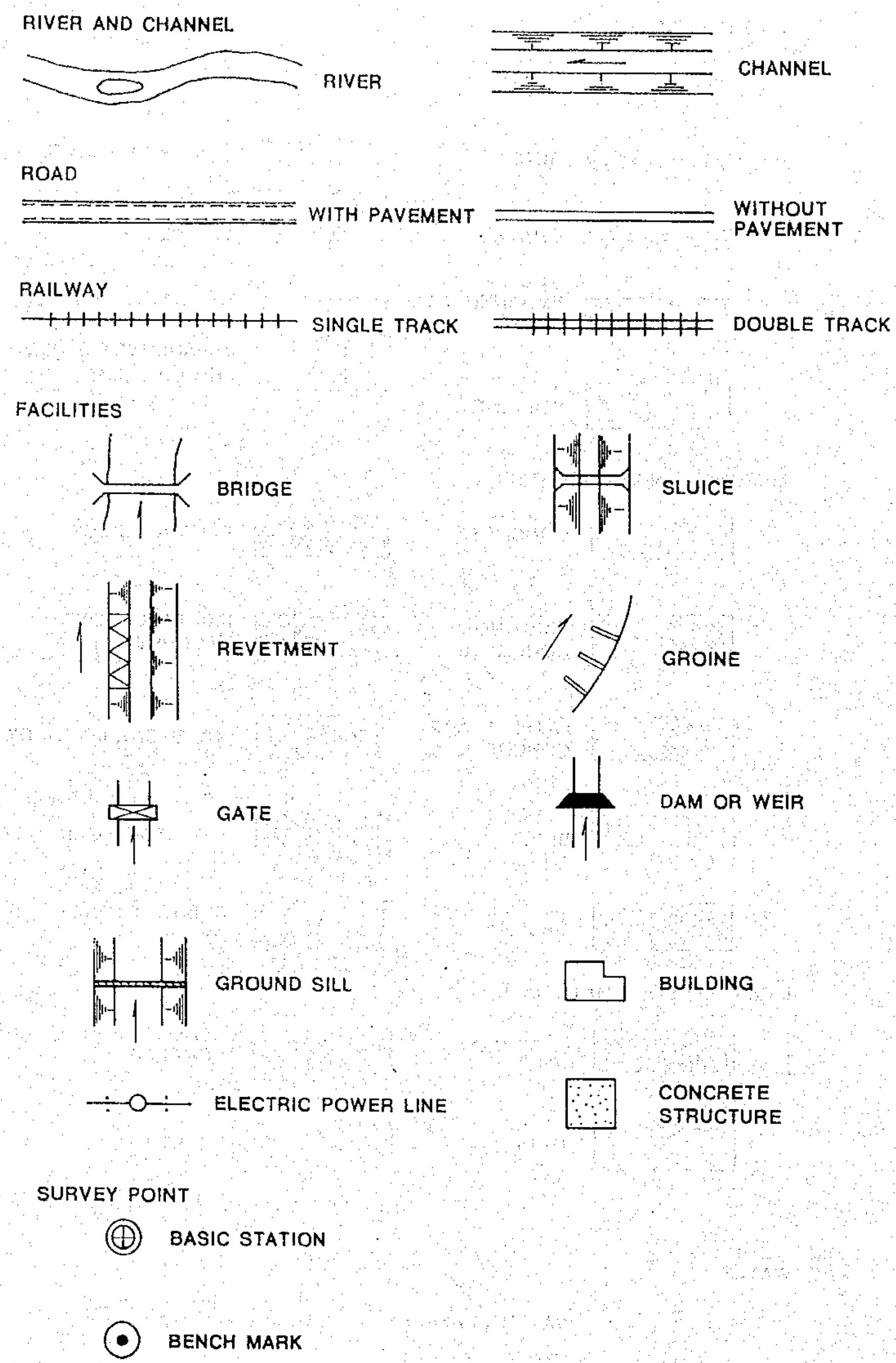


Fig. 5.7 (1/2) SYMBOLS FOR MAPPING

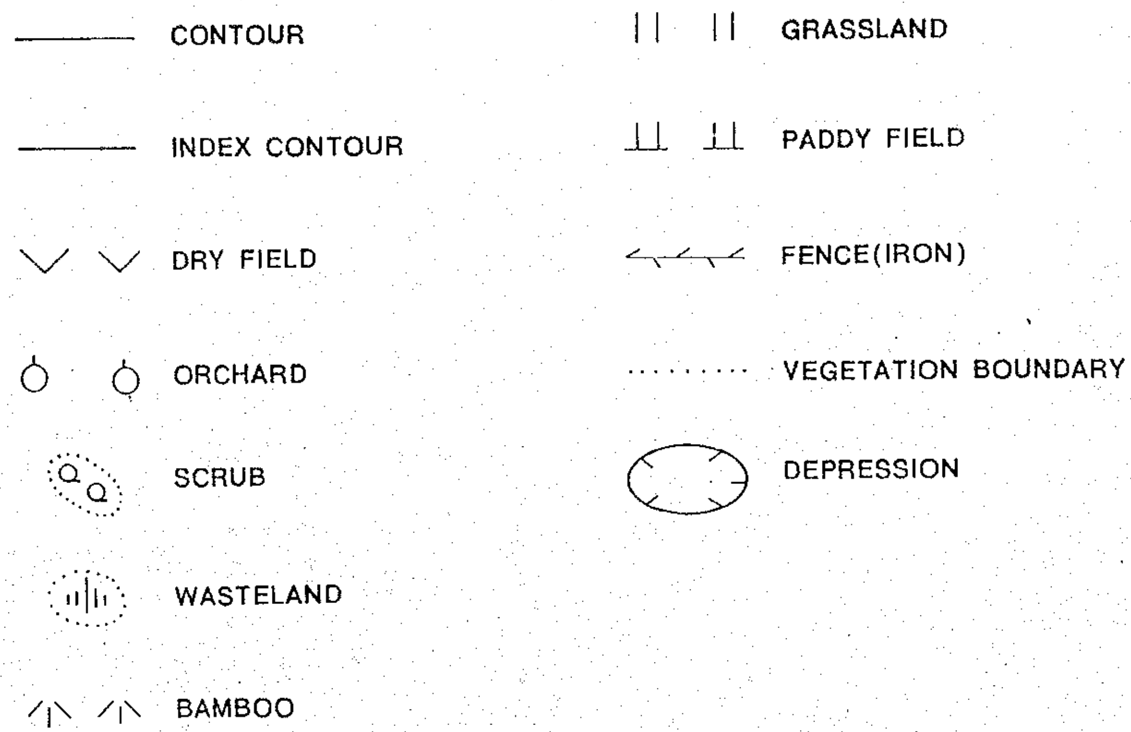


Fig. 5.7 (2/2) SYMBOLS FOR MAPPING